

**U. S. Department of Energy**



**Thomas Jefferson National Accelerator Facility**

**300**  
**Scheduling and Budgeting**

### **300 Scheduling and Budgeting**

This chapter of the Project Control System Manual describes the planning processes required to develop a practical project plan that can be implemented by the designated project team. The major goal of this planning effort is an integrated project schedule and budget. Schedule planning results in a schedule that describes the sequence of technical work and the task interdependencies necessary for a successful project outcome. Cost planning begins with the development of a cost estimate for all authorized work that will be resource loaded into the schedule and eventually lead to the establishment of the project budget. Proper project planning ensures the amount of work to be accomplished, the time allotted to accomplish the project activities, and the resources required to complete the work scope are evenly balanced. Once the schedule and cost planning are concluded, the resultant plans can be merged to form a time-phased project budget that is seamlessly integrated with the resource loaded network schedule. This initial project budget is validated and approved as the Integrated Project Baseline and is endorsed by the project team as the Performance Measurement Baseline, a foundational element of earned value management. Meaningful earned value performance metrics enable better management insight and decision making to help keep the project on track.

### **301 Schedule Planning**

The objectives of schedule planning are 1) to generate a reasonable schedule of work that leads to project completion; and 2) to establish a Schedule Baseline that, when integrated with a Cost Baseline using resource loading techniques, will result in an Integrated Project Baseline for the project. The core of the schedule planning process is the Schedule Management System and its associated schedule software. This system provides the requisite program management tools to plan and sequence project milestones and activities, to assign resources to the activities, to monitor progress of activities toward project objectives, to forecast future schedule performance, and to provide the basis for earned value and performance calculations.

#### **301.1 Schedule Management System**

- A. The Enterprise Suite consists of schedule and cost software packages that are part of the overall Jefferson Lab Enterprise Project Structure. The central component to the Schedule Management System is the Enterprise Suite schedule software. It is a powerful and flexible scheduling tool that is used to perform time analyses of logic network, maintain baseline and status information, prepare standard reports at regular intervals and special custom reports as needed, and provide the basis for earned value and performance calculations by seamless connectivity to the Cost Management System.

1. Time analysis is the process of calculating the earliest start and finish dates and the latest start and finish dates of each activity, based on the duration of the activities, the logical relationships between them and the desired completion date of the project. In addition to these calculations, the scheduling software also determines free float (the amount of time an activity can be delayed without delaying subsequent activities), total float (the amount of time an activity can be delayed without delaying project completion as a whole), and the critical path (the longest path from the logic network start to finish and the sequence of activities with the least total float). Any delay in a critical path activity will extend the total project schedule.
  2. For each activity in the project schedule, the scheduling software maintains the early start, early finish, late start, late finish, and, after they occur, the actual start and the actual finish dates in the Working Detail Schedule. Actual starts and finishes affect the remainder of the logic network by changing the early and late start and finishes of subsequent activities in the Working Detail Schedule. Therefore, a time analysis is conducted in the Working Detail Schedule after each status update. The scheduling software also maintains a separate file of baseline start dates, baseline finish dates and other baseline data in the Schedule Baseline. These baseline dates are not affected by actual starts and finishes. Instead they are retained for comparisons between planned and actual dates.
  3. The scheduling software produces reports in three different formats: Gantt chart, logic diagram or in tabular format, and has flexible report generation routines. The use of relational databases and the manner in which the information is coded permit the creation of special reports, as needed. These are useful to assess the effects of various schedule alternatives, to extract portions of the project, or to select categories of milestones/activities for review.
- B. The scheduling group within the Office of Project Management is responsible for administration of the Schedule Management System. This includes schedule preparation, horizontal and vertical integration of elements of the scheduling system, maintenance of schedule baselines, status reporting, and programming enhancements to the scheduling system. Information is obtained from all levels of project management in carrying out these responsibilities.

## **301.2 Schedule Development**

### **A. Baseline Milestones (Exhibit 5)**

The schedule planning process begins with the determination of the Baseline Milestones. These level 1 and 2 milestones with their planned dates form a master schedule for the project. This top-level schedule contains significant events and critical decision points that could affect the technical, schedule, and/or cost performance of the project. The Baseline Milestones and their associated definitions are mutually developed by the Jefferson Lab Project Director/Manager and the Project Customer. They are re-examined and rescheduled, if necessary, during customer reviews. Based on the decisions by the Project Customer and the Project Director/Manager, OPM develops the Baseline Milestones Schedule of planned and proposed dates for each milestone.

### **B. Intermediate Milestones (Exhibit 6)**

Once the Baseline Milestones Schedule has been created, the next level of detail can be incorporated by designating the project's Intermediate Milestones. The Intermediate Milestones are level 3 and 4 elements and provide a secondary level of scheduling. These Intermediate Milestones are selected by the Project Director/Manager and the Associate Project Managers.

### **C. Detail Milestones**

To complete the milestone schedule development, the Cost Account Managers generate level 5 and 6 Detail Milestones.

### **D. Detail Schedule (Exhibit 7)**

The Baseline Milestones Schedule, populated with the Intermediate and Detail Milestones, serves as the framework to add the work activities to the project schedule. The detail schedule is developed from the Cost Account Plans initiated by the Cost Account Managers during the cost planning process (see section 303 Integrated Project Baseline Development). OPM incorporates the schedule and resource information contained in the Cost Account Plans and builds a comprehensive schedule logic sequence that includes the sequence, start and finish dates and duration of every activity required to complete the project. The resulting detail schedule contains all project milestones, the work activities, and the logical ties between the schedule elements. This then becomes the Schedule Baseline of the project.

## E. Working Detail Schedule

While the Schedule Baseline constitutes the performance standard against which actual progress is compared, the Working Detail Schedule is a working tool for evaluating schedule plans and projecting future progress. In order to preserve its value as a baseline, changes to the Schedule Baseline are carefully controlled and documented. On the other hand, the Working Detail Schedule is continuously revised as actual activity status and completion dates are entered and their effects on future scheduled activities are calculated.

Consequently, this results in changes to early and late, start and finish dates that may no longer be consistent with the Schedule Baseline. These revised dates are used to forecast when detail, intermediate and baseline milestones will actually be accomplished, and to guide management corrective action.

## 302 Cost Planning

- A. Cost planning is the other major planning activity required to develop an Integrated Project Baseline. The purpose of cost planning is to identify the resources needed to accomplish the scope of work and estimate the associated costs. Cost represents the dollar value required to accomplish the technical work scope within schedule and programmatic constraints. A preliminary cost estimate can be started after an initial Work Breakdown Structure is developed. Cost estimate integration with the WBS occurs when the work scope in each WBS element, each Cost Account, and each scheduled work package/activity has a definitive cost/resource estimate associated with it. Once the cost estimate is approved at all management levels, it becomes the Cost Baseline, i.e., the project's budget.
  
- B. Elements of the cost estimate include both direct charges and indirect charges. Direct charges are costs applicable to, and identified specifically with, the project work scope and examples of these types of costs include labor, travel, material, subcontractor costs, etc. Indirect charges are costs that cannot be consistently or economically identified against a specific Jefferson Lab project and are spread over the total laboratory project portfolio. Cost estimating is a continuous process initiated during the conceptual phase and refined throughout project execution.

### 302.1 Cost Management System

The Cost Management System is an integral element of the Enterprise Suite software package used at Jefferson Lab. Initial budget data enters the Cost Management System via its link to the Schedule Management System. Direct and indirect costs are imported from the Lab's financial system. The Cost

Management System, together with the Schedule Management System, form an integrated cost/schedule database that enables the project management team to understand a project's costs at the transaction level.

### **302.2 Cost Estimating**

A disciplined and systematic cost estimating process will promote integrity in a new project. As project performance will be measured against the project baselines, it is important that an accurate cost estimate be determined early in the project. Project management may use a top down approach, a bottoms-up approach, or a combination methodology when generating a cost estimate.

### **302.3 Funding Guidance**

In formulating an initial cost estimate for the project, the Project Customer usually provides funding guidance to the Project Director/Manager that delineates the proposed total budget for the project and may include a fiscal year breakout. The Project Customer may elect to hold in reserve some budget from the total project cost as Contingency funds. The Project Director/Manager uses the funding guidance to establish a project funding profile across the WBS Level 2. Target budgets are developed and distributed to the Associate Project Managers and Cost Account Managers. This represents the Project Director/Manager's guidance to Associate Project Managers and Cost Account Managers when they develop the details of the cost estimate for their portion of the project. As with the Project Customer, the Project Director/Manager can withhold Management Reserve funds at the project level to adjust for any uncertainty that may arise during the execution of the project plan.

### **302.4 Cost Estimate Development**

- A. Once the Project Director/Manager has established an initial funding profile for the project, the Office of Project Management will prepare a Cost Sheet form (Exhibit 8) for each Cost Account. The Cost Sheet documents the most up-to-date plan for fiscal year and total dollar obligations that are anticipated from specific assignments of labor, expense, and procurement resources to each Cost Account. Using the Cost Sheet, the Cost Account Managers form an initial cost estimate for their Cost Accounts showing the dollars expected to be committed by fiscal year.
- B. After the initial Cost Sheets have been developed, an extensive project management evaluation and validation of the proposed project cost is accomplished. Multi-level dialogue among the Project Director/Manager, the Office of Project Management, Associate Project Managers, and the Cost Account Managers will be required to reach consensus on a final cost profile for the project. Summary Cost Sheets are prepared by OPM for each higher-

level element in the WBS and are used by the Associate Project Managers and the Project Director/Manager to identify areas where actions must be taken to restructure work scope or reassess resource requirements to meet anticipated fiscal year and total project funding constraints. With an agreement on the final cost profile, the Cost Account Managers will revise the Cost Sheets and OPM will update the Summary Cost Sheets. Overhead rates and escalation factors are applied to dollar figures in the Cost Sheet from information supplied by the Chief Financial Office.

- C. Cost Sheets and Summary Cost Sheets are assembled in a project's Cost Book. This document represents the total estimated cost for the work scope identified as necessary for successful accomplishment of the project and is used to establish the Cost Baseline.

### **303 Integrated Project Baseline Development**

- A. While the Cost Sheet shows the dollars expected to be committed by fiscal year, it does not include the specific months during which resources will be applied or the specific tasks that will be accomplished. These details are contained in the Cost Account Plan. Using the Cost Account Plan sheet (Exhibit 9), the Cost Account Manager develops work activities to divide the Cost Account into discrete manageable and measurable segments of work for the purpose of developing plans and determining progress. Each activity is sequenced in a manner that provides logical support for the project schedule. Work activities are at or below the reporting requirements such that earned value performance measurement takes place at the Cost Account level.
- B. With the work activities identified in the Cost Account Plan, the Cost Account Manager determines the types of resources (labor, expenses, procurements) required and the quantity (hours, dollars) needed for each resource element. Labor resources are estimated according to various cost element categories, such as Plant Engineer, Mechanical Engineer, and Scientist, etc. Expense estimates are prepared for such items as supplies and materials, travel, and consulting. Labor and expense estimates are assigned to the month/fiscal year during which they will be used or expended. Estimates for procurements are also made and are assigned to the month/fiscal year in which payment is anticipated to occur. Dollar amounts for all cost estimates are entered in current year direct dollars. Once the resources have been identified and their costs estimated, a schedule of the work activities is developed with start dates and activity durations annotated in the Cost Account Plan. Data from the Cost Account Plans is used to develop the Detail Schedule as discussed in section 301.2 Schedule Development.

- C. One essential product of the Cost Account Plan is the identification of the types and levels of labor resources that must be provided by each functional organization supplying labor to the project. Summary reports showing labor requirements in support of work scope as documented in the Cost Account Plans are prepared by Project Services and used by senior project management to assure the availability of such personnel when needed.
  
- D. At this stage in the planning process, three project baselines have been established: the Technical Baseline, the Schedule Baseline, and the Cost Baseline. The Technical Baseline, organized around a WBS framework, describes the desired configuration, performance, and characteristics of the project and establishes the project's mission, technical objectives, and functional requirements. The required work activities to satisfy the project's mission need are logically linked in a Schedule Baseline integrating the entire work scope while reflecting all programmatic constraints. The Cost Baseline is based on validated cost estimates developed for the project work scope and ensures resources for labor, services, subcontracts, and materials are established at the requisite levels. In total, these three baselines produce the Integrated Project Baseline. The Integrated Project Baseline lays the foundation through which project objectives can be achieved and progress can be managed and monitored during project execution. Data that form the Integrated Project Baseline is recorded in an integrated cost/schedule database using the Cost and Schedule Management Systems. These systems share the data to produce a resource-loaded schedule and time-phased budget plan.

### **303.1 Performance Measurement Baseline**

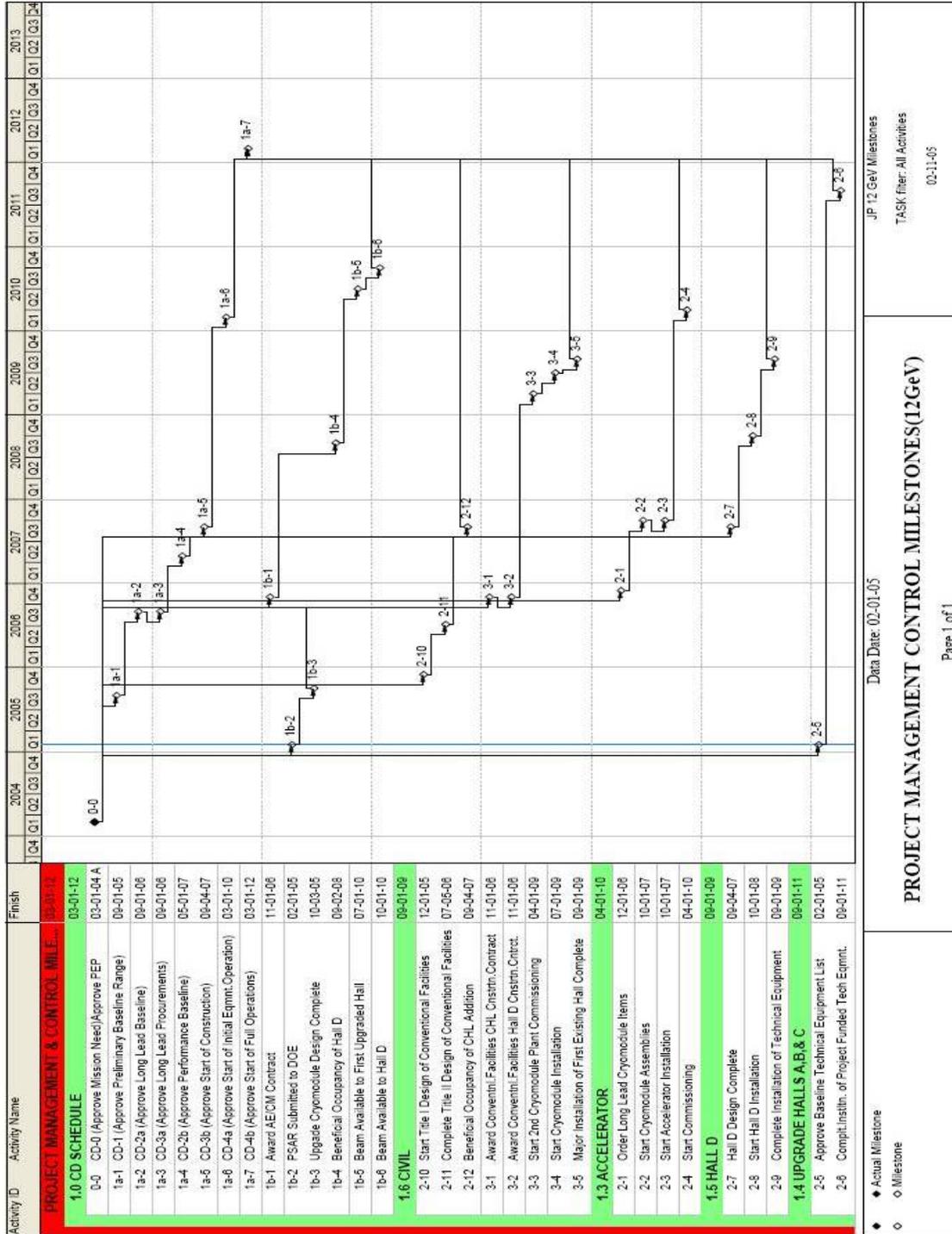
- A. Once the Integrated Project Baseline has been validated by project management, this baseline becomes the Performance Measurement Baseline. This time-phased budget plan encompasses all the individual work activities at the Cost Account level with the dollars and resources necessary to accomplish them. Within the Performance Measurement Baseline, any budget not yet specifically identified with a Cost Account may be designated Undistributed Budget. Undistributed Budget is a transient amount and should be allocated in a reasonably timely manner. The Performance Measurement Baseline sets the criteria against which actual performance is measured during project execution. For Jefferson Lab projects over \$5M dollars, an Earned Value Management System will be implemented to assess the value of the accomplished work against the planned budget (i.e., the Performance Measurement Baseline) in order to identify problem areas early and develop a recovery plan.
  
- B. The Earned Value Management System employs three sets of project data to provide project management with insight into the progress of the project. From the Performance Measurement Baseline, the Budgeted Cost of Work

Scheduled (BCWS) can be established. This metric represents the sum of the time-phased budgets established for all effort scheduled to be accomplished within a given time period. BCWS can be called “Planned Value.” At the project completion time point, the BCWS should equal the Budget At Completion (BAC). BAC is the budgetary goal for accomplishing all of the authorized work contained in the cost accounts. While BCWS is derived from project planning, Budgeted Cost of Work Performed (BCWP, the second set of data) is determined during project execution. BCWP, or “Earned Value,” is the sum of the time-phased budgets for work completed during a specified time period; i.e., the value of the work accomplished. The third set of data, also collected during project execution, is Actual Cost of Work Performed (ACWP) or “Actual Costs.” Actual Costs are the project costs incurred and recorded in accomplishing the work performed (i.e., Earned Value) within a given time period. With these three earned value metrics, project management can evaluate the status of the project in relation to the technical, schedule, and cost baselines established for the project. An Estimate At Completion (EAC) can be calculated that sums the actual costs incurred to date plus the estimate of costs for all authorized work remaining. Additional detail on the Earned Value Management System is provided in chapters 600 Progress Status and 700 Analysis and Reporting of the Project Control System Manual.

### **304 Exhibits**

5. Baseline Milestones Example
6. Intermediate Milestones Example
7. Detail Schedule Example
8. Cost Sheet Example
9. Cost Account Plan Example

Exhibit 5. Baseline Milestones Schedule Example



♦ Actual Milestone  
 ○ Milestone

Data Date: 02-01-05  
 JP 12 GeV Milestones  
 TASK: Filter: All Activities  
 02-11-05

**PROJECT MANAGEMENT CONTROL MILESTONES(12GeV)**  
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Exhibit 7. Detail Schedule Example

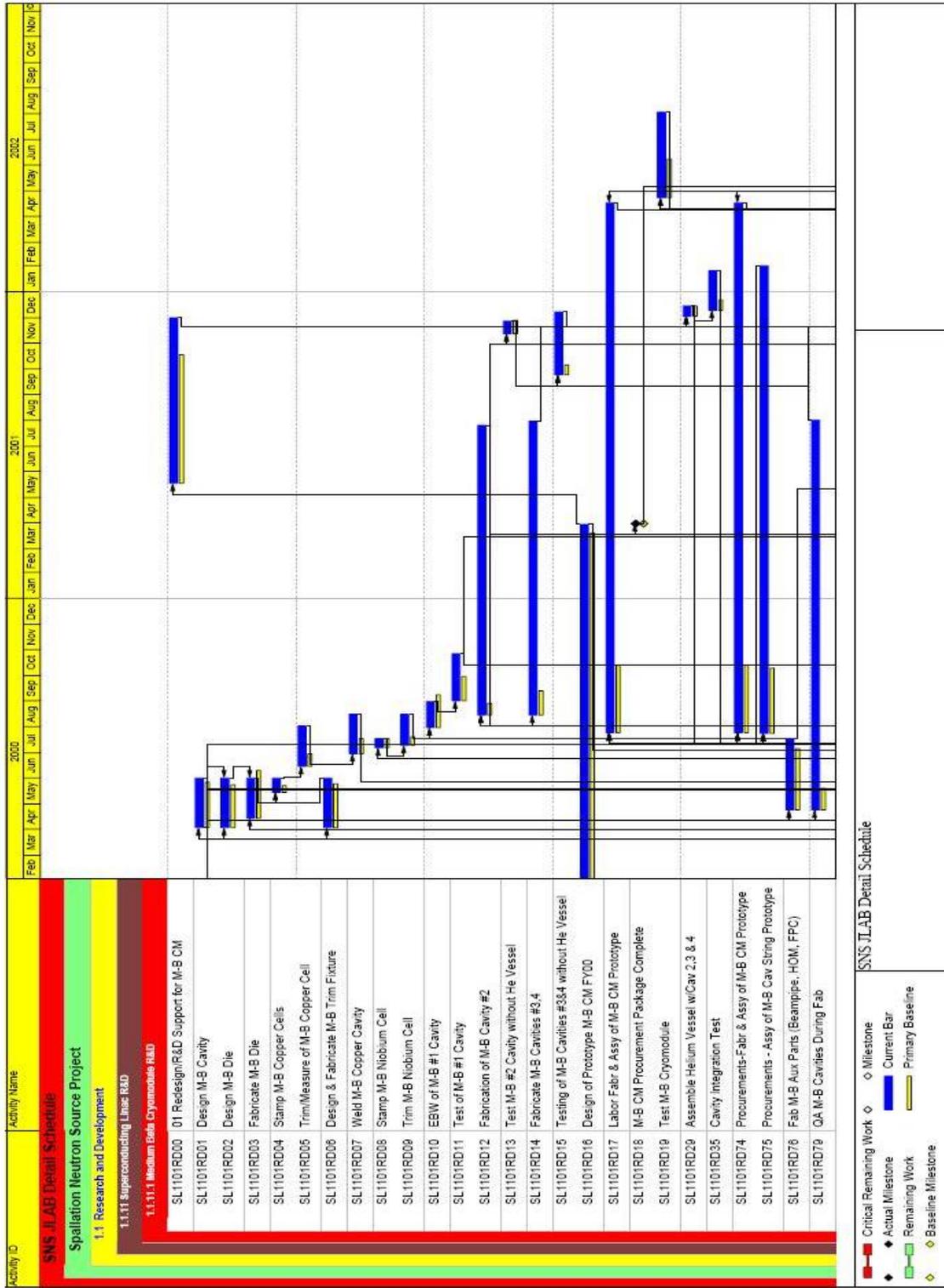




Exhibit 8. Cost Sheet Example

1.3.3.1.1 Compressors		Construction - Accel Systems						06/02/05	15.34	Data Entry
DESCRIPTION: 12 GeV CHL Main warm helium compressor equipment purchase and field placement installation costs										
INHOUSE LABOR (MANWEEKS)				ETC PURCHASED LABOR (MW's)						
	Weekly Rate	ETC	Sum Total		Weekly Rate	ETC	Sum Total		ETC	Sum Total
Plant Eng	2.2			Elect Engr	2.3	4 MW	\$9 K	Mech Engr/Dsgn		
Plant Dsgn	1.5			Elect Dsgn	1.5	4 MW	\$6 K	Mech Tech		
Plant Tech	1.3			Elect Tech	1.4	6 MW	\$8 K	Elect Engr/Dsgn		
Skilled Trades	1.3			Proj Admin	2.6			Elect Tech		
Mech Eng	2.3	4 MW	\$9 K	Scientists	2.4			Electrician		
Mech Dsgn	1.5	4 MW	\$6 K	Comp Scientist	2.1			Plumb/Weld		
Mech Tech	1.3	16 MW	\$21 K	Office	1.0			Rig&Oper		
Contributed University Labor				Paid University Staff	1.9			Laborer		
Visiting Users	0.7			Paid University Student	0.5			Consultant (\$)		
	FY __ Actuals + Committed	FY __ Actuals + Committed	FY __ Actuals + Committed	Cost + Committed To Date Total	Estimate to complete in FY05 \$	Estimate at Completion	FY __ Review Cost Estimate in FY __ \$	Variance	%	Contingency
Labor	Manweeks				38	38		-38		6
	FTE Years				0.9	0.9		-0.9		0.1
TOTAL LABOR \$					60 \$K	60 \$K		-60 \$K	15.0%	9 \$K
\$ per FTE YEAR	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	\$70 K	\$70 K		\$70 K		\$70 K
Supplies & Materials										
Travel										
Consult & Prof Labor										
Machine Shop Labor										
TOTAL EXPENSES									#DIV/0!	
Major Components/A&E < \$50K					\$228 K	\$228 K		-\$228 K		\$46 K
Major Components/A&E > \$50K					\$3,550 K	\$3,550 K		-\$3,550 K		\$710 K
TOTAL PROCUREMENTS					\$3,778 K	\$3,778 K		-\$3,778 K	20.0%	\$756 K
Total Costs (NO overhead)					\$3,838 K	\$3,838 K		-\$3,838 K	19.9%	\$765 K
Labor w/overhead					\$66 K	\$66 K		-\$66 K		\$10 K
Expenses w/overhead										
Procurement w/overhead					\$3,801 K	\$3,801 K		-\$3,801 K		\$760 K
GRAND TOTAL					\$3,867 K	\$3,867 K		-\$3,867 K		\$770 K
YEAR	FY 2004/05	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012+	Total	
LABOR - Obligation					\$66 K				\$66 K	\$10 K
EXPENSES - Obligation										
PROCUREMENTS - Obligation				\$1,405 K	\$2,105 K	\$291 K			\$3,801 K	\$760 K
PROCUREMENTS - Cost										
TOTAL				\$1,405 K	\$2,171 K	\$291 K			\$3,867 K	\$770 K
ESCL TOTAL				\$1,515 K	\$2,335 K	\$325 K			\$4,243 K	
MANWEEKS	FY 2004/05	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012+	Total	
Plant Eng										
Plant Dsgn										
Plant Tech										
Skilled Trades, Electrician										
Mech Eng					4 MW				4 MW	
Mech Dsgn					4 MW				4 MW	
Mech Tech					16 MW				16 MW	
Elect Engr					4 MW				4 MW	
Elect Dsgn					4 MW				4 MW	
Elect Tech					6 MW				6 MW	
Proj Admin										
Scientists										
Comp Scientist										
Office										
Contributed University Labor										
Visiting Users										
Paid University Staff										
Paid University Students										
TOTAL MANWEEKS					38 MW				38 MW	
EXPENSES - Obligation	-	-	-	-	-	-	-	-	-	-
PROCUREMENTS <50K	-	-	-	50	50	128	-	-	228	
PROCUREMENTS >50K	-	-	-	1,350	2,050	150	-	-	3,550	

